

**$\psi(2S)$**  $I^G(J^{PC}) = 0^-(1^{--})$  **$\psi(2S)$  MASS**

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
<b><math>3685.96 \pm 0.09</math> OUR NEW AVERAGE</b>		[3686.00 $\pm$ 0.09 MeV OUR 1998 AVERAGE]		
3685.95 $\pm$ 0.10	413	<sup>1</sup> ARTAMONOV 00	OLYA	$e^+ e^- \rightarrow$ hadrons
3686.02 $\pm$ 0.09 $\pm$ 0.27		ARMSTRONG 93B	E760	$\bar{p}p \rightarrow e^+ e^-$
<b>• • • We do not use the following data for averages, fits, limits, etc. • • •</b>				
3684 $\pm$ 2		GRIBUSHIN 96	FMPS	$515 \pi^- Be \rightarrow 2\mu X$
3683 $\pm$ 5	77	ANTONIAZZI 94	E705	$300 \pi^\pm, pLi \rightarrow J/\psi \pi^+ \pi^- X$
3686.00 $\pm$ 0.10	413	<sup>2</sup> ZHOLENTZ 80	OLYA	$e^+ e^-$
1 Reanalysis of ZHOLENTZ 80 using new electron mass (COHEN 87) and radiative corrections (KURAEV 85).				
2 Superseded by ARTAMONOV 00.				

 **$m_{\psi(2S)} - m_{J/\psi(1S)}$** 

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b><math>589.07 \pm 0.13</math> OUR AVERAGE</b>			
589.7 $\pm$ 1.2	LEMOIGNE 82	GOLI	$190 \pi^- Be \rightarrow 2\mu$
589.07 $\pm$ 0.13	<sup>3</sup> ZHOLENTZ 80	OLYA	$e^+ e^-$
588.7 $\pm$ 0.8	LUTH 75	MRK1	
<b>• • • We do not use the following data for averages, fits, limits, etc. • • •</b>			
588 $\pm$ 1	<sup>4</sup> BAI	98E BES	$e^+ e^-$
3 Redundant with data in mass above.			
4 Systematic errors not evaluated.			

 **$\psi(2S)$  WIDTH**

VALUE (keV)	DOCUMENT ID	TECN	COMMENT
<b><math>277 \pm 31</math> OUR AVERAGE</b>	Error includes scale factor of 1.1.		
306 $\pm$ 36 $\pm$ 16	ARMSTRONG 93B	E760	$\bar{p}p \rightarrow e^+ e^-$
243 $\pm$ 43	<sup>5</sup> PDG	92	RVUE

<sup>5</sup> Uses  $\Gamma(ee)$  from ALEXANDER 89 and  $B(ee) = (88 \pm 13) \times 10^{-4}$  from FELDMAN 77.

 **$\psi(2S)$  DECAY MODES**

Mode	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level
$\Gamma_1$ hadrons	(98.10 $\pm$ 0.30) %	
$\Gamma_2$ virtual $\gamma \rightarrow$ hadrons	( 2.9 $\pm$ 0.4 ) %	
$\Gamma_3$ $e^+ e^-$	( 8.8 $\pm$ 1.3 ) $\times 10^{-3}$	
$\Gamma_4$ $\mu^+ \mu^-$	( 1.03 $\pm$ 0.35 ) %	

### Decays into $J/\psi(1S)$ and anything

$\Gamma_5$	$J/\psi(1S)$ anything	(55 $\pm$ 5 ) %
$\Gamma_6$	$J/\psi(1S)$ neutrals	(23.1 $\pm$ 2.3 ) %
$\Gamma_7$	$J/\psi(1S)\pi^+\pi^-$	(31.0 $\pm$ 2.8 ) %
$\Gamma_8$	$J/\psi(1S)\pi^0\pi^0$	(18.2 $\pm$ 2.3 ) %
$\Gamma_9$	$J/\psi(1S)\eta$	( 2.7 $\pm$ 0.4 ) %
$\Gamma_{10}$	$J/\psi(1S)\pi^0$	( 9.7 $\pm$ 2.1 ) $\times 10^{-4}$

### Hadronic decays

$\Gamma_{11}$	$3(\pi^+\pi^-)\pi^0$	( 3.5 $\pm$ 1.6 ) $\times 10^{-3}$
$\Gamma_{12}$	$2(\pi^+\pi^-)\pi^0$	( 3.0 $\pm$ 0.8 ) $\times 10^{-3}$
$\Gamma_{13}$	$\omega f_2(1270)$	< 1.7 $\times 10^{-4}$
$\Gamma_{14}$	$\rho a_2(1320)$	< 2.3 $\times 10^{-4}$
$\Gamma_{15}$	$\pi^+\pi^-K^+K^-$	( 1.6 $\pm$ 0.4 ) $\times 10^{-3}$
$\Gamma_{16}$	$K^*(892)\bar{K}_2^*(1430)^0$	< 1.2 $\times 10^{-4}$
$\Gamma_{17}$	$K_1(1270)^\pm K^\mp$	( 1.00 $\pm$ 0.28 ) $\times 10^{-3}$
$\Gamma_{18}$	$\pi^+\pi^- p\bar{p}$	( 8.0 $\pm$ 2.0 ) $\times 10^{-4}$
$\Gamma_{19}$	$K^+\bar{K}^*(892)^0\pi^- + \text{c.c.}$	( 6.7 $\pm$ 2.5 ) $\times 10^{-4}$
$\Gamma_{20}$	$b_1^\pm\pi^\mp$	( 5.2 $\pm$ 1.3 ) $\times 10^{-4}$
$\Gamma_{21}$	$2(\pi^+\pi^-)$	( 4.5 $\pm$ 1.0 ) $\times 10^{-4}$
$\Gamma_{22}$	$\rho^0\pi^+\pi^-$	( 4.2 $\pm$ 1.5 ) $\times 10^{-4}$
$\Gamma_{23}$	$\bar{p}p$	( 1.9 $\pm$ 0.5 ) $\times 10^{-4}$
$\Gamma_{24}$	$3(\pi^+\pi^-)$	( 1.5 $\pm$ 1.0 ) $\times 10^{-4}$
$\Gamma_{25}$	$\bar{p}p\pi^0$	( 1.4 $\pm$ 0.5 ) $\times 10^{-4}$
$\Gamma_{26}$	$K^+K^-$	( 1.0 $\pm$ 0.7 ) $\times 10^{-4}$
$\Gamma_{27}$	$\pi^+\pi^-\pi^0$	( 8 $\pm$ 5 ) $\times 10^{-5}$
$\Gamma_{28}$	$\rho\pi$	< 8.3 $\times 10^{-5}$
$\Gamma_{29}$	$\pi^+\pi^-$	( 8 $\pm$ 5 ) $\times 10^{-5}$
$\Gamma_{30}$	$\Lambda\bar{\Lambda}$	< 4 $\times 10^{-4}$
$\Gamma_{31}$	$K_1(1400)^\pm K^\mp$	< 3.1 $\times 10^{-4}$
$\Gamma_{32}$	$\Xi^-\bar{\Xi}^+$	< 2 $\times 10^{-4}$
$\Gamma_{33}$	$K^+K^-\pi^0$	< 2.96 $\times 10^{-5}$
$\Gamma_{34}$	$K^+\bar{K}^*(892)^- + \text{c.c.}$	< 5.4 $\times 10^{-5}$
$\Gamma_{35}$	$\phi f'_2(1525)$	< 4.5 $\times 10^{-5}$

### Radiative decays

$\Gamma_{36}$	$\gamma\chi_{c0}(1P)$	( 9.3 $\pm$ 0.9 ) %
$\Gamma_{37}$	$\gamma\chi_{c1}(1P)$	( 8.7 $\pm$ 0.8 ) %
$\Gamma_{38}$	$\gamma\chi_{c2}(1P)$	( 7.8 $\pm$ 0.8 ) %
$\Gamma_{39}$	$\gamma\eta_c(1S)$	( 2.8 $\pm$ 0.6 ) $\times 10^{-3}$
$\Gamma_{40}$	$\gamma\eta_c(2S)$	

$\Gamma_{41}$	$\gamma\pi^0$					
$\Gamma_{42}$	$\gamma\eta'(958)$		$(1.5 \pm 0.4) \times 10^{-4}$			
$\Gamma_{43}$	$\gamma\eta$		$< 9 \times 10^{-5}$	CL=90%		
$\Gamma_{44}$	$\gamma\gamma$		$< 1.6 \times 10^{-4}$	CL=90%		
$\Gamma_{45}$	$\gamma\eta(1440) \rightarrow \gamma K\bar{K}\pi$		$< 1.2 \times 10^{-4}$	CL=90%		

### Mode needed for fitting purposes

$\Gamma_{46}$	1. — other fit modes	$(21 \pm 5) \%$
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## CONSTRAINED FIT INFORMATION

An overall fit to 10 branching ratios uses 17 measurements and one constraint to determine 8 parameters. The overall fit has a  $\chi^2 = 9.0$  for 10 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients  $\langle \delta x_i \delta x_j \rangle / (\delta x_i \cdot \delta x_j)$ , in percent, from the fit to the branching fractions,  $x_i \equiv \Gamma_i / \Gamma_{\text{total}}$ . The fit constrains the  $x_i$  whose labels appear in this array to sum to one.

$x_7$	27					
$x_8$	17	63				
$x_9$	2	9	3			
$x_{36}$	0	0	0	0		
$x_{37}$	0	-1	-5	0	0	
$x_{38}$	0	0	-2	0	0	0
$x_{46}$	-30	-89	-83	-15	-17	-13
						-15
	$x_4$	$x_7$	$x_8$	$x_9$	$x_{36}$	$x_{37}$
					$x_{38}$	

## $\psi(2S)$ PARTIAL WIDTHS

### $\Gamma(\text{hadrons})$

$\Gamma_1$

VALUE (keV)	DOCUMENT ID	TECN	COMMENT
<b>• • • We do not use the following data for averages, fits, limits, etc. • • •</b>			
$224 \pm 56$	LUTH	75	MRK1 $e^+ e^-$

### $\Gamma(e^+ e^-)$

$\Gamma_3$

VALUE (keV)	DOCUMENT ID	TECN	COMMENT
<b>2.12 ± 0.18 OUR NEW AVERAGE</b>	[ $2.14 \pm 0.21$ keV OUR 1998 AVERAGE]		
$2.07 \pm 0.32$	<sup>6</sup> BAI	98E BES	$e^+ e^-$
$2.14 \pm 0.21$	ALEXANDER	89 RVUE	See $\gamma$ mini-review
<b>• • • We do not use the following data for averages, fits, limits, etc. • • •</b>			
$2.0 \pm 0.3$	BRANDELIK	79C DASP	$e^+ e^-$
$2.1 \pm 0.3$	<sup>7</sup> LUTH	75	MRK1 $e^+ e^-$

<sup>6</sup> Value includes radiative corrections computed by ALEXANDER 89.

<sup>7</sup> From a simultaneous fit to  $e^+ e^-$ ,  $\mu^+ \mu^-$ , and hadronic channels assuming  $\Gamma(e^+ e^-) = \Gamma(\mu^+ \mu^-)$ .

$\Gamma(\gamma\gamma)$ 

<u>VALUE</u> (eV)	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<43	90	BRANDELIK	79C DASP	$e^+ e^-$

 $\Gamma_{44}$  $\psi(2S) \Gamma(i) \Gamma(e^+ e^-)/\Gamma(\text{total})$ 

This combination of a partial width with the partial width into  $e^+ e^-$  and with the total width is obtained from the integrated cross section into channel  $i$  in the  $e^+ e^-$  annihilation. We list only data that have not been used to determine the partial width  $\Gamma(i)$  or the branching ratio  $\Gamma(i)/\text{total}$ .

 $\Gamma(\text{hadrons}) \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$  $\Gamma_1 \Gamma_3/\Gamma$ 

<u>VALUE</u> (keV)	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$\bullet \bullet \bullet$ We do not use the following data for averages, fits, limits, etc. $\bullet \bullet \bullet$			
$2.2 \pm 0.4$	ABRAMS	75	MRK1 $e^+ e^-$

 $\psi(2S) \text{ BRANCHING RATIOS}$  $\Gamma(\text{hadrons})/\Gamma_{\text{total}}$  $\Gamma_1/\Gamma$ 

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$0.981 \pm 0.003$	8 LUTH	75	MRK1 $e^+ e^-$

 $\Gamma(\text{virtual } \gamma \rightarrow \text{hadrons})/\Gamma_{\text{total}}$  $\Gamma_2/\Gamma$ 

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$0.029 \pm 0.004$	9 LUTH	75	MRK1 $e^+ e^-$

 $\Gamma(e^+ e^-)/\Gamma_{\text{total}}$  $\Gamma_3/\Gamma$ 

<u>VALUE</u> (units $10^{-4}$ )	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$88 \pm 13$ OUR NEW AVERAGE	$[(85 \pm 7) \times 10^{-4}$ OUR 1998 AVERAGE]		

 $88 \pm 13$ 10 FELDMAN 77 RVUE  $e^+ e^-$  $\bullet \bullet \bullet$  We do not use the following data for averages, fits, limits, etc.  $\bullet \bullet \bullet$  $83 \pm 5 \pm 7$ 11 ARMSTRONG 97 E760  $\bar{p}p \rightarrow \psi(2S)X$  $\Gamma(\mu^+ \mu^-)/\Gamma_{\text{total}}$  $\Gamma_4/\Gamma$ 

<u>VALUE</u> (units $10^{-4}$ )	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$77 \pm 17$	12 HILGER	75	SPEC $e^+ e^-$

 $\Gamma(\mu^+ \mu^-)/\Gamma(e^+ e^-)$  $\Gamma_4/\Gamma_3$ 

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$\bullet \bullet \bullet$ We do not use the following data for averages, fits, limits, etc. $\bullet \bullet \bullet$			

 $0.89 \pm 0.16$ BOYARSKI 75C MRK1  $e^+ e^-$ 8 Includes cascade decay into  $J/\psi(1S)$ .9 Included in  $\Gamma(\text{hadrons})/\Gamma_{\text{total}}$ .10 From an overall fit assuming equal partial widths for  $e^+ e^-$  and  $\mu^+ \mu^-$ . For a measurement of the ratio see the entry  $\Gamma(\mu^+ \mu^-)/\Gamma(e^+ e^-)$  below. Includes LUTH 75, HILGER 75, BURMESTER 77.11 Using  $B(J/\psi \rightarrow e^+ e^-) = 0.0599 \pm 0.0025$  and  $B(\psi(2S) \rightarrow J/\psi(1S)\text{anything}) = 0.57 \pm 0.04$ . Not an independent measurement, see GU 99.12 Restated by us using  $B(\psi(2S) \rightarrow J/\psi(1S)\text{anything}) = 0.55$ .

———— DECAYS INTO  $J/\psi(1S)$  AND ANYTHING ——

$$\Gamma(J/\psi(1S)\text{anything})/\Gamma_{\text{total}} \quad \Gamma_5/\Gamma = (\Gamma_7 + \Gamma_8 + \Gamma_9 + 0.273\Gamma_{37} + 0.135\Gamma_{38})/\Gamma$$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.55 ± 0.05 OUR NEW UNCHECKED FIT</b>	[0.542 ± 0.030 OUR 1998 FIT]		
<b>0.55 ± 0.07 OUR AVERAGE</b>			
0.51 ± 0.12	BRANDELIK 79C DASP	$e^+ e^- \rightarrow \mu^+ \mu^- X$	
0.57 ± 0.08	ABRAMS 75B MRK1	$e^+ e^- \rightarrow \mu^+ \mu^- X$	

$$\Gamma(J/\psi(1S)\text{neutrals})/\Gamma_{\text{total}}$$

$$\Gamma_6/\Gamma = (0.9761\Gamma_8 + 0.715\Gamma_9 + 0.273\Gamma_{37} + 0.135\Gamma_{38})/\Gamma$$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.231 ± 0.023 OUR NEW UNCHECKED FIT</b>	[0.228 ± 0.017 OUR 1998 FIT]		

$$\Gamma(J/\psi(1S)\text{neutrals})/\Gamma(J/\psi(1S)\text{anything})$$

$$\Gamma_6/\Gamma_5 = (0.9761\Gamma_8 + 0.715\Gamma_9 + 0.273\Gamma_{37} + 0.135\Gamma_{38})/(\Gamma_7 + \Gamma_8 + \Gamma_9 + 0.273\Gamma_{37} + 0.135\Gamma_{38})$$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.418 ± 0.019 OUR NEW UNCHECKED FIT</b>	[0.421 ± 0.021 OUR 1998 FIT]		

• • • We do not use the following data for averages, fits, limits, etc. • • •

0.44 ± 0.03	13 ABRAMS	75B MRK1	$e^+ e^- \rightarrow J/\psi X$
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$$\Gamma(J/\psi(1S)\text{neutrals})/\Gamma(J/\psi(1S)\pi^+\pi^-)$$

$$\Gamma_6/\Gamma_7 = (0.9761\Gamma_8 + 0.715\Gamma_9 + 0.273\Gamma_{37} + 0.135\Gamma_{38})/\Gamma_7$$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.75 ± 0.06 OUR NEW UNCHECKED FIT</b>	[0.76 ± 0.07 OUR 1998 FIT]		
<b>0.73 ± 0.09</b>	13 TANENBAUM 76	MRK1	$e^+ e^-$

$$\Gamma(J/\psi(1S)\pi^+\pi^-)/\Gamma_{\text{total}}$$

$$\Gamma_7/\Gamma$$

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.310 ± 0.028 OUR NEW UNCHECKED FIT</b>	[0.302 ± 0.019 OUR 1998 FIT]			
<b>0.32 ± 0.04 OUR NEW AVERAGE</b>	[0.296 ± 0.023 OUR 1998 AVERAGE]			
<b>0.32 ± 0.04</b>	ABRAMS	75B MRK1	$e^+ e^- \rightarrow J/\psi \pi^+ \pi^-$	
0.283 ± 0.021 ± 0.020	363	14 ARMSTRONG 97 E760	$\bar{p}p \rightarrow \psi(2S)X$	

$$\Gamma(J/\psi(1S)\pi^0\pi^0)/\Gamma_{\text{total}}$$

$$\Gamma_8/\Gamma$$

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.182 ± 0.023 OUR NEW UNCHECKED FIT</b>	[0.179 ± 0.018 OUR 1998 FIT]			
0.184 ± 0.019 ± 0.013	157	14 ARMSTRONG 97 E760	$\bar{p}p \rightarrow \psi(2S)X$	

$$\Gamma(J/\psi(1S)\pi^0\pi^0)/\Gamma(J/\psi(1S)\pi^+\pi^-)$$

$$\Gamma_8/\Gamma_7$$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.59 ± 0.06 OUR FIT</b>			
<b>0.609 ± 0.079</b>	15 GU	99 RVUE	
0.53 ± 0.06	16 TANENBAUM 76	MRK1	$e^+ e^-$
0.64 ± 0.15	17 HILGER	75 SPEC	$e^+ e^-$

$\Gamma(J/\psi(1S)\pi^+\pi^-)/\Gamma(\mu^+\mu^-)$

$\Gamma_7/\Gamma_4$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>30 ±10 OUR FIT</b>			
<b>30.2± 7.1±6.8</b>	18 GRIBUSHIN	96 FMPS	515 $\pi^-$ Be → $2\mu X$

$\Gamma(J/\psi(1S)\eta)/\Gamma_{\text{total}}$

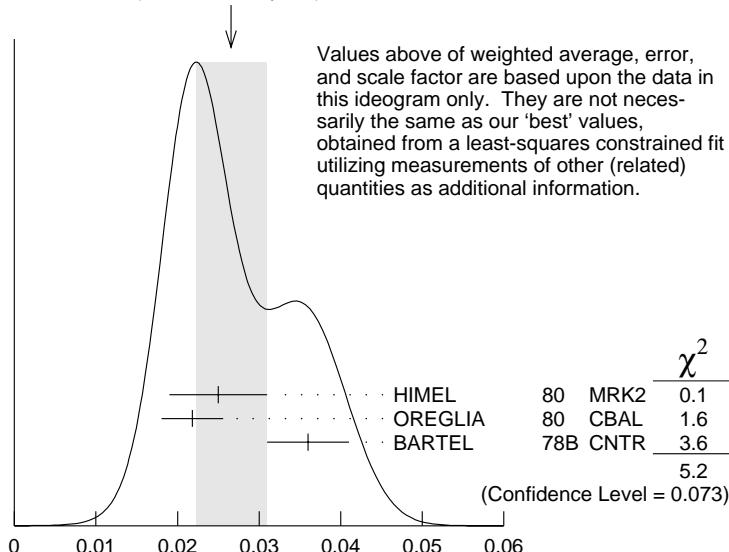
$\Gamma_9/\Gamma$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
<b>0.027 ±0.004 OUR NEW UNCHECKED FIT</b>				Error includes scale factor of 1.6. [0.027 ± 0.004 OUR 1998 FIT Scale factor = 1.7]

**0.027 ±0.004 OUR AVERAGE** Error includes scale factor of 1.6. See the ideogram below.

0.025 ±0.006	166	HIMEL	80	MRK2 $e^+e^-$
0.0218±0.0014±0.0035	386	OREGLIA	80	CBAL $e^+e^- \rightarrow J/\psi 2\gamma$
0.036 ±0.005	164	BARTEL	78B	CNTR $e^+e^-$
<b>• • • We do not use the following data for averages, fits, limits, etc. • • •</b>				
0.032 ±0.010 ±0.002	36	19 ARMSTRONG	97 E760	$\bar{p}p \rightarrow \psi(2S)X$
0.035 ±0.009	17	19 BRANDELIK	79B DASP	$e^+e^- \rightarrow J/\psi 2\gamma$
0.043 ±0.008	44	19 TANENBAUM	76 MRK1	$e^+e^-$

WEIGHTED AVERAGE  
0.027±0.004 (Error scaled by 1.6)



$\Gamma(J/\psi(1S)\eta)/\Gamma_{\text{total}}$

$\Gamma(J/\psi(1S)\eta)/\Gamma(J/\psi(1S)\text{anything})$

$$\Gamma_9/\Gamma_5 = \Gamma_9 / (\Gamma_7 + \Gamma_8 + \Gamma_9 + 0.273\Gamma_{37} + 0.135\Gamma_{38})$$

VALUE	DOCUMENT ID	TECN
<b>0.049±0.008 OUR FIT</b>		Error includes scale factor of 1.3.
<b>0.062±0.016</b>	15 GU	99 RVUE

$\Gamma(J/\psi(1S)\pi^0)/\Gamma_{\text{total}}$ 

<u>VALUE</u> (units $10^{-4}$ )	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	$\Gamma_{10}/\Gamma$
<b><math>9.7 \pm 2.1</math> OUR AVERAGE</b>					
15 $\pm 6$	7	HIMEL	80	MRK2 $e^+ e^-$	
9 $\pm 2$ $\pm 1$	23	OREGLIA	80	CBAL $\psi(2S) \rightarrow J/\psi 2\gamma$	

<sup>13</sup> The ABRAMS 75B measurement of  $\Gamma_6/\Gamma_5$  and the TANENBAUM 76 result for  $\Gamma_6/\Gamma_7$  are not independent. The TANENBAUM 76 result is used in the fit because it includes more accurate corrections for angular distributions.

<sup>14</sup> Using  $B(J/\psi \rightarrow e^+ e^-) = 0.0599 \pm 0.0025$  and  $B(\psi(2S) \rightarrow J/\psi(1S)\text{anything}) = 0.57 \pm 0.04$ .

<sup>15</sup> Using data from ARMSTRONG 97.

<sup>16</sup> Not independent of the TANENBAUM 76 result for  $\Gamma_6/\Gamma_7$ .

<sup>17</sup> Ignoring the  $J/\psi(1S)\eta$  and  $J/\psi(1S)\gamma\gamma$  decays.

<sup>18</sup> Using  $B(J/\psi(1S) \rightarrow \mu^+ \mu^-) = 0.0597 \pm 0.0025$ .

<sup>19</sup> Low statistics data removed from average.

**HADRONIC DECAYS** $\Gamma(3(\pi^+\pi^-)\pi^0)/\Gamma_{\text{total}}$ 

<u>VALUE</u> (units $10^{-4}$ )	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	$\Gamma_{11}/\Gamma$
<b><math>35 \pm 16</math></b>	6	FRANKLIN	83	MRK2 $e^+ e^- \rightarrow \text{hadrons}$	

 $\Gamma(2(\pi^+\pi^-)\pi^0)/\Gamma_{\text{total}}$ 

<u>VALUE</u> (units $10^{-4}$ )	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	$\Gamma_{12}/\Gamma$
<b><math>30 \pm 8</math></b>	42	FRANKLIN	83	MRK2 $e^+ e^-$	

 $\Gamma(\pi^+\pi^- K^+ K^-)/\Gamma_{\text{total}}$ 

<u>VALUE</u> (units $10^{-4}$ )	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	$\Gamma_{15}/\Gamma$
<b><math>16 \pm 4</math></b>		20 TANENBAUM 78	MRK1	$e^+ e^-$	

 $\Gamma(K_1(1270)^{\pm} K^{\mp})/\Gamma_{\text{total}}$ 

<u>VALUE</u> (units $10^{-4}$ )	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	$\Gamma_{17}/\Gamma$
<b><math>10.0 \pm 1.8 \pm 2.1</math></b>		21 BAI	99C BES	$e^+ e^-$	

 $\Gamma(\pi^+\pi^- p\bar{p})/\Gamma_{\text{total}}$ 

<u>VALUE</u> (units $10^{-4}$ )	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	$\Gamma_{18}/\Gamma$
<b><math>8 \pm 2</math></b>		20 TANENBAUM 78	MRK1	$e^+ e^-$	

 $\Gamma(K^+\bar{K}^*(892)^0\pi^- + \text{c.c.})/\Gamma_{\text{total}}$ 

<u>VALUE</u> (units $10^{-4}$ )	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	$\Gamma_{19}/\Gamma$
<b><math>6.7 \pm 2.5</math></b>		TANENBAUM 78	MRK1	$e^+ e^-$	

 $\Gamma(b_1^{\pm}\pi^{\mp})/\Gamma_{\text{total}}$ 

<u>VALUE</u> (units $10^{-4}$ )	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	$\Gamma_{20}/\Gamma$
<b><math>5.2 \pm 0.8 \pm 1.0</math></b>		22 BAI	99C BES	$e^+ e^-$	

$\Gamma(2(\pi^+\pi^-))/\Gamma_{\text{total}}$ VALUE (units  $10^{-4}$ ) **$4.5 \pm 1.0$**  $\Gamma(\omega f_2(1270))/\Gamma_{\text{total}}$ VALUE (units  $10^{-4}$ ) **$<1.7$** 

90

 $\Gamma(\rho^0\pi^+\pi^-)/\Gamma_{\text{total}}$ VALUE (units  $10^{-4}$ ) **$4.2 \pm 1.5$**  $\Gamma(\rho a_2(1320))/\Gamma_{\text{total}}$ VALUE (units  $10^{-4}$ ) **$<2.3$** 

90

 $\Gamma(\bar{p}p)/\Gamma_{\text{total}}$ VALUE (units  $10^{-4}$ ) **$1.9 \pm 0.5$  OUR AVERAGE**

4

 $1.4 \pm 0.8$  $2.3 \pm 0.7$  $\Gamma(3(\pi^+\pi^-))/\Gamma_{\text{total}}$ VALUE (units  $10^{-4}$ ) **$1.5 \pm 1.0$**  $\Gamma(\bar{p}p\pi^0)/\Gamma_{\text{total}}$ VALUE (units  $10^{-4}$ ) **$1.4 \pm 0.5$** 

9

 $\Gamma(K^+K^-)/\Gamma_{\text{total}}$ VALUE (units  $10^{-4}$ ) **$1.0 \pm 0.7$** 

• • • We do not use the following data for averages, fits, limits, etc. • • •

 $<0.5$ 

90

FELDMAN

77

MRK1

 $e^+e^-$  $\Gamma(\pi^+\pi^-)/\Gamma_{\text{total}}$ VALUE (units  $10^{-4}$ ) **$0.8 \pm 0.5$** 

• • • We do not use the following data for averages, fits, limits, etc. • • •

 $<0.5$ 

90

FELDMAN

77

MRK1

 $e^+e^-$  $\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{\text{total}}$ VALUE (units  $10^{-4}$ ) **$0.85 \pm 0.46$** 

4

FRANKLIN

83

MRK2

 $e^+e^- \rightarrow \text{hadrons}$  $\Gamma_{21}/\Gamma$ 

DOCUMENT ID	TECN	COMMENT
TANENBAUM 78	MRK1	$e^+e^-$

 $\Gamma_{13}/\Gamma$ 

DOCUMENT ID	TECN	COMMENT
BAI	98J	BES

 $\Gamma_{22}/\Gamma$ 

DOCUMENT ID	TECN	COMMENT
TANENBAUM 78	MRK1	$e^+e^-$

 $\Gamma_{14}/\Gamma$ 

DOCUMENT ID	TECN	COMMENT
BAI	98J	BES

 $\Gamma_{23}/\Gamma$ 

DOCUMENT ID	TECN	COMMENT
BRANDELIK 79C	DASP	$e^+e^-$
FELDMAN 77	MRK1	$e^+e^-$

 $\Gamma_{24}/\Gamma$ 

DOCUMENT ID	TECN	COMMENT
20 TANENBAUM 78	MRK1	$e^+e^-$

 $\Gamma_{25}/\Gamma$ 

DOCUMENT ID	TECN	COMMENT
FRANKLIN 83	MRK2	$e^+e^-$

 $\Gamma_{26}/\Gamma$ 

DOCUMENT ID	TECN	COMMENT
BRANDELIK 79C	DASP	$e^+e^-$
FELDMAN 77	MRK1	$e^+e^-$

 $\Gamma_{29}/\Gamma$ 

DOCUMENT ID	TECN	COMMENT
BRANDELIK 79C	DASP	$e^+e^-$
FELDMAN 77	MRK1	$e^+e^-$

 $\Gamma_{27}/\Gamma$ 

DOCUMENT ID	TECN	COMMENT
FRANKLIN 83	MRK2	$e^+e^- \rightarrow \text{hadrons}$

$\Gamma(\Lambda\bar{\Lambda})/\Gamma_{\text{total}}$

VALUE (units $10^{-4}$ )	CL%
<4	90

$\Gamma_{30}/\Gamma$

DOCUMENT ID	TECN	COMMENT
FELDMAN	77	MRK1 $e^+ e^-$

$\Gamma(K_1(1400)^{\pm} K^{\mp})/\Gamma_{\text{total}}$

VALUE (units $10^{-4}$ )	CL%
<3.1	90

$\Gamma_{31}/\Gamma$

DOCUMENT ID	TECN	COMMENT
BAI	99C	BES $e^+ e^-$

$\Gamma(\Xi^-\bar{\Xi}^+)/\Gamma_{\text{total}}$

VALUE (units $10^{-4}$ )	CL%
<2	90

$\Gamma_{32}/\Gamma$

DOCUMENT ID	TECN	COMMENT
FELDMAN	77	MRK1 $e^+ e^-$

$\Gamma(\rho\pi)/\Gamma_{\text{total}}$

VALUE (units $10^{-4}$ )	CL%	EVTS
< 0.83	90	1

• • • We do not use the following data for averages, fits, limits, etc. • • •

VALUE (units $10^{-4}$ )	CL%	EVTS
<10	90	
<10	90	

DOCUMENT ID	TECN	COMMENT
FRANKLIN	83	MRK2 $e^+ e^-$

$\Gamma(K^+ K^- \pi^0)/\Gamma_{\text{total}}$

VALUE (units $10^{-5}$ )	CL%	EVTS
<2.96	90	1

$\Gamma_{33}/\Gamma$

DOCUMENT ID	TECN	COMMENT
FRANKLIN	83	MRK2 $e^+ e^- \rightarrow \text{hadrons}$

$\Gamma(K^+ \bar{K}^*(892)^- + \text{c.c.})/\Gamma_{\text{total}}$

VALUE (units $10^{-5}$ )	CL%
<5.4	90

$\Gamma_{34}/\Gamma$

DOCUMENT ID	TECN	COMMENT
FRANKLIN	83	MRK2 $e^+ e^- \rightarrow \text{hadrons}$

$\Gamma(K^*(892)\bar{K}_2^*(1430)^0)/\Gamma_{\text{total}}$

VALUE (units $10^{-4}$ )	CL%
<1.2	90

$\Gamma_{16}/\Gamma$

DOCUMENT ID	TECN	COMMENT
BAI	98J	BES $e^+ e^-$

$\Gamma(\phi f'_2(1525))/\Gamma_{\text{total}}$

VALUE (units $10^{-4}$ )	CL%
<0.45	90

$\Gamma_{35}/\Gamma$

DOCUMENT ID	TECN	COMMENT
BAI	98J	BES $e^+ e^- \rightarrow 2(K^+ K^-)$

20 Assuming entirely strong decay.

21 Assuming  $B(K_1(1270) \rightarrow K\rho) = 0.42 \pm 0.06$

22 Assuming  $B(b_1 \rightarrow \omega\pi) = 1$ .

23 Assuming  $B(K_1(1400) \rightarrow K^*\pi) = 0.94 \pm 0.06$

24 Final state  $\rho^0\pi^0$ .

———— RADIATIVE DECAYS ————

$\Gamma(\gamma\chi_{c0}(1P))/\Gamma_{\text{total}}$

VALUE (units $10^{-2}$ )	CL%
<b>9.3±0.9 OUR FIT</b>	
<b>9.3±0.8 OUR AVERAGE</b>	

9.9  $\pm$  0.5  $\pm$  0.8

7.2  $\pm$  2.3

7.5  $\pm$  2.6

$\Gamma_{36}/\Gamma$

DOCUMENT ID	TECN	COMMENT
GAISER	86	CBAL $e^+ e^- \rightarrow \gamma X$

DOCUMENT ID	TECN	COMMENT
BIDDICK	77	CNTR $e^+ e^- \rightarrow \gamma X$

DOCUMENT ID	TECN	COMMENT
WHITAKER	76	MRK1 $e^+ e^-$

$\Gamma(\gamma\chi_{c1}(1P))/\Gamma_{\text{total}}$

VALUE (units  $10^{-2}$ )

**$8.7 \pm 0.8$  OUR FIT**

**$8.7 \pm 0.8$  OUR AVERAGE**

$9.0 \pm 0.5 \pm 0.7$

$7.1 \pm 1.9$

<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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<sup>26</sup> GAISER      86    CBAL     $e^+ e^- \rightarrow \gamma X$   
<sup>27</sup> BIDDICK      77    CNTR     $e^+ e^- \rightarrow \gamma X$

$\Gamma_{37}/\Gamma$

$\Gamma(\gamma\chi_{c2}(1P))/\Gamma_{\text{total}}$

VALUE (units  $10^{-2}$ )

**$7.8 \pm 0.8$  OUR FIT**

**$7.8 \pm 0.8$  OUR AVERAGE**

$8.0 \pm 0.5 \pm 0.7$

$7.0 \pm 2.0$

<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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<sup>28</sup> GAISER      86    CBAL     $e^+ e^- \rightarrow \gamma X$   
<sup>27</sup> BIDDICK      77    CNTR     $e^+ e^- \rightarrow \gamma X$

$\Gamma_{38}/\Gamma$

$\Gamma(\gamma\eta_c(1S))/\Gamma_{\text{total}}$

VALUE (units  $10^{-2}$ )

**$0.28 \pm 0.06$**

<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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GAISER      86    CBAL     $e^+ e^- \rightarrow \gamma X$

$\Gamma_{39}/\Gamma$

$\Gamma(\gamma\eta_c(2S))/\Gamma_{\text{total}}$

VALUE (units  $10^{-2}$ )

CL%

<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

0.2 to 1.3      95      EDWARDS      82C CBAL     $e^+ e^- \rightarrow \gamma X$

$\Gamma_{40}/\Gamma$

$\Gamma(\gamma\pi^0)/\Gamma_{\text{total}}$

VALUE (units  $10^{-4}$ )

CL%

<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

< 54      95      <sup>29</sup> LIBERMAN      75    SPEC     $e^+ e^-$   
<100      90      WIJK      75    DASP     $e^+ e^-$

$\Gamma_{41}/\Gamma$

$\Gamma(\gamma\eta'(958))/\Gamma_{\text{total}}$

VALUE (units  $10^{-4}$ )

**$1.54 \pm 0.31 \pm 0.20$**

CL%

<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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$\sim 43$       BAI      98F BES     $\psi(2S) \rightarrow \pi^+ \pi^- 2\gamma,$   
 $\pi^+ \pi^- 3\gamma$

$\Gamma_{42}/\Gamma$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<60      90      <sup>30</sup> BRAUNSCH...      77    DASP     $e^+ e^-$   
<11      90      <sup>31</sup> BARTEL      76    CNTR     $e^+ e^-$

$\Gamma(\gamma\eta)/\Gamma_{\text{total}}$

$\Gamma_{43}/\Gamma$

VALUE (units  $10^{-4}$ )

**<0.9 (CL = 90%)** [ $<0.02 \times 10^{-2}$  (CL = 90%) OUR 1992 BEST LIMIT]

<0.9      90      BAI      98F BES     $\psi(2S) \rightarrow \pi^+ \pi^- 3\gamma$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<2      90      YAMADA      77    DASP     $e^+ e^- \rightarrow 3\gamma$

$\Gamma(\gamma\eta(1440) \rightarrow \gamma K\bar{K}\pi)/\Gamma_{\text{total}}$  $\Gamma_{45}/\Gamma$ 

<u>VALUE</u> (units $10^{-3}$ )	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>&lt;0.12</b>	90	32 SCHARRE	80	MRK1 $e^+ e^-$
25		Angular distribution ( $1+\cos^2\theta$ ) assumed.		
26		Angular distribution ( $1-0.189 \cos^2\theta$ ) assumed.		
27		Valid for isotropic distribution of the photon.		
28		Angular distribution ( $1-0.052 \cos^2\theta$ ) assumed.		
29		Restated by us using $B(\psi(2S) \rightarrow \mu^+ \mu^-) = 0.0077$ .		
30		Restated by us using total decay width 228 keV.		
31		The value is normalized to the branching ratio for $\Gamma(J/\psi(1S)\eta)/\Gamma_{\text{total}}$ .		
32		Includes unknown branching fraction $\eta(1440) \rightarrow K\bar{K}\pi$ .		

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